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Army Worms and Cut Worms Attacking Sugar Cane

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INTRODUCTION

There are 35 or more species of cut worms and army worms known in the Hawaiian Islands. Of these, the majority are native and live mostly in the mountains or high plains. Only two of the native species (*Agrotis dislocata* and *Agrotis crinigera*) have so far become pests in cane fields. The other native species have apparently been kept in check by their parasites and other enemies, or remain at higher elevations than cane fields. Some species are quite rare, but others sometimes become abundant locally.

Besides the two native species mentioned above, the other species treated of in this circular are cosmopolitan, occurring in most of the warmer parts of the globe. They are pests, wherever known. The army worm (*Leucania unipuncta*) is undoubtedly the worst one of them, in the cane fields here. But usually to be found amongst these are one or more of the species of *Agrotis,* though the latter usually are not nearly so numerous as the former, and probably the most of the injury to the cane is done by the army worm (*Leucania*).

From reports of devastation done by these caterpillars in previous years, apparently they are not nearly so serious a pest at present, though I have seen, during the past three years, fields of young cane very badly stripped by them, and hence kept back for a while at the beginning, when it was desirable for it to be getting a good start. The critical time for the cane is when it first comes up. If the army worms are numerous, they will probably eat the leaves from the young shoots as fast as they appear. Since the growing heart of the cane-shoot is within, and lower down than where they attack it, the shoot is not killed outright, as would be a tomato, cabbage or tobacco plant if cut off at the surface of the ground; hence, their work in cane fields is not so disastrous as in many other crops. The young shoots of cane, although temporarily checked, eventually reach a growth beyond the attack of the caterpillars, higher than they will climb.

The various species of caterpillars may be readily identified by comparing them with the figures on the plates, likewise the moths, more satisfactorily than from descriptions.

THE ARMY WORM.

Leucania unipuncta (Haw.)

Plate III, figs. 3-6.

This insect occurs as a pest in many widely separated parts of the globe. In the United States it is a bad pest on corn and other cereals. It ranges from Canada south to all southern parts of North America, West Indies, and then South America to Argentina and Chile. It occurs in Madeira, Azores, Britain and South Europe; Southeastern Siberia, Japan, China, India, Malay Islands, Australia, and New Zealand. It has sporadic outbreaks, when it is extremely destructive to grass and farm crops devastating whole fields and travelling in army-like migrations to others adjacent. Fortunately there are numerous parasites, which keep it in check for most of the time; but for unexplained reasons there are times when they increase beyond the control of parasites and predators, and are temporarily very destructive, until again checked by the increase of the parasites.

In these islands, they usually occur in the lowlands and grassy regions; and when abundant in sugar cane fields it is those fields which adjoin fields of grass, or which have more or less grassy gulches in them, or in fields which have been recently planted on land that had lain fallow and had grown up with grass and weeds, or had been in pasture for a time. Although the moths breed more or less the year round, they are more prolific, or breed more favorably during the so-called winter months, November to April. In many districts there is more rain during these months and growths of grass occur favorable for the feeding of the caterpillars. At this time of the year, in fields of young cane situated as above designated, they often are present in sufficient numbers to severely check the growth of the cane. They, in connection with other cut worms, sometimes strip the leaves of the cane, leaving nothing but midribs. This may be only in certain parts of the field, or it may be over a considerable area of it. As the caterpillars feed for about three weeks or a month, while getting their growth, the cane will be checked for this length of time; but after the caterpillars of one brood have become full-grown and cease feeding, there will be a period of a few weeks before the next brood, so

that the cane will have a chance of recovery, and the larger it gets the better is it able to withstand further attacks.

LIFE HISTORY AND HABITS.

The egg of the army worm is spherical, smooth, white, and opaque when first laid, becoming faintly iridescent and more sordid before hatching. Its average diameter is 0.6 mm. The eggs are usually placed at the base of the leaves or thrust in behind the leaf sheath, but may often be deposited amongst trash or debris as well. The eggs are glued on to the objects, wherever they are deposited, and are commonly in rows of 15 to 20; but sometimes they are as few as 2 or 3, and again as many as nearly a hundred may be in one batch. The moths deposit their eggs in the early part of the night, even before dark sometimes. One female may deposit several hundred eggs (500-700) and may occupy two or more evenings so doing.

The eggs hatch in a week or ten days, depending on the temperature. The young caterpillars first crawl by a looping motion on account of the fact that the first and the second pairs of abdominal prolegs are rudimentary. After the first molt only the first pair are rudimentary, and after the second molt all prolegs are functional and the caterpillar crawls in the normal manner. There are five molts at intervals of three to six days, and the growing period is thus about three to four weeks, depending on the temperature. The caterpillars usually feed on the plants at night-time and hide during the day beneath leaves or trash on the surface of the ground, or in the soil a little below the surface, or sometimes even remain on the plant and feed more or less or hide in a fold of leaf or behind a leaf sheath or other convenient place. Those feeding on the leaves in the daytime drop to the ground on the slightest disturbance and coil up, remaining motionless for a time. The feeding of the army worm is not like some of the cutworms in that it feeds on the leaves instead of eating the stem of a plant and thus cutting it off at or near the surface of the ground. The evidences of their feeding on sugar cane are easily detected; the lower leaves of the young cane-shoots being notched and ragged where they have eaten the blade of the leaf, and when numerous, in fact, the blades of the leaves entirely eaten away, leaving nothing but the hard midribs.

The full-grown caterpillar (Plate III, fig. 4) is 35-40 mm. long, or about one and one-half inches. General color greenish brown with longitudinal blackish stripes on back and sides, much paler below. The stripes are as follows: a wide, pale blackish stripe on the back with an interrupted white line in the middle; outside of this is a narrow pinkish brown stripe; then next a still wider blackish stripe darker along its lower edge, which contains the black oval spiracles, or breathing pores; below this is another pinkish brown stripe having whitish lines on each edge. The head is pale brown, each lobe with a network of darker brown and running up and down in front are two blackish bands diverging below. First segment behind head nearly all brown dorsally. A dark brown spot on outer side of each proleg. Hairs small, situated in inconspicuous tubercles.

The coloration varies somewhat and the stripes are sometimes less distinct. The younger stages are colored about the same; often paler, and sometimes nearly black.

When full-grown, the caterpillar burrows into the soil and at a depth of two to four inches constructs an oval earthen cell, within which after a few days it transforms to the pupa (Plate III, fig. 5). The pupa is of a shiny dark brown color, about 18 mm. long and 4.5 mm. thick, rounded at anterior end and tapering posteriorly to a blunt point which is armed with two nearly straight parallel spines, hooked at the tip, and placed near together. There are four other slender hooked bristles, one lateral and another a little dorsal of each of the larger spines (Plate III, fig. 6). The wing-cases terminate roundedly at the apex of the fourth abdominal segment. On the bases of abdominal segments 5, 6 and 7 is a dorsal black line containing a row of 12-20 pits. These segments are movable.

The moth emerges from the pupa in about ten days to two weeks. It makes its way above the surface, and, clinging to some object, its soft wings soon become expanded and dried, and the moth is fully matured, after a period of from six to eight weeks, or sometimes more, according to temperature.

The moth with wings expanded measures 40-45 mm. (Plate III, fig. 3). Usually the wings are folded flatly on the back when at rest. The moth is of a light grey color with a yellowish brown tinge on fore wings which are minutely sprinkled with black scales, also a row of black dots on the termen of the wing

and a curved row of black dots a little removed from the termen. A dark line extends obliquely inward a short distance from apex of wing. A white dot near middle of wing. The hind wings have a dark dot a little before middle, they are darker on the veins and on the posterior part. The sexes are of similar coloration; but the antenna of the male is more ciliated. The male has also larger tufts of hair at apex of abdomen, and a tuft of long hairs on each side of abdomen at base, usually hidden by the ordinary hair of the body. (These latter tufts I have found no mention of in any of the numerous descriptions of the moth.)

THE GRASS ARMY WORM.

Spodoptera mauritia Boisd.

Plate II, figs. 7-11.

This moth occurs in Mauritius, West Africa, and throughout the Oriental and Australian regions. Its caterpillars were formerly a very serious pest in the grass lands and sugar cane fields of the Hawaiian Islands; but their numbers were greatly reduced by the introduction of the Mynah bird. Now they are no longer a serious pest, though they are often numerous in grass, where the Mynah birds may be seen searching for them; but before the Mynah bird was introduced, it is reported that often whole fields of young sugar cane were eaten by them; and that the grass slopes in the valleys and mountains would be entirely consumed by them at times; in fact, they were in millions and behaved much like army worms. Besides feeding upon grasses and sugar cane, they also eat corn, peas, beans, and probably other kinds of garden plants.

During January and February, 1906, they caused considerable trouble at the Experiment Station by attacking the tiny cane seedlings which were being propagated. It required daily examination, and careful search, for the tiny larvae were green like the leaves; and although small, yet were big enough for one of them to soon destroy one of the little cane seedlings (which were 1-2 inches high) if not detected soon after it had started feeding. Fortunately they did not work after the manner of cutworms and cut a plant off immediately. Instead, they began eating at the tips of leaves, and they could be first detected by the dried remains of tips of leaves where they had

fed, then closer looking would reveal the tiny green caterpillar, which on being disturbed dropped to the ground and could be readily killed. Usually but one caterpillar was found on one seedling; but sometimes more, even as many as four, in which case they soon destroyed the plants.

LIFE HISTORY.

The eggs (Plate II, figs. 10, 11) are spherical, slightly flattened at base where in contact with the object upon which they are deposited. They are dirty whitish or gray in color, and densely striated vertically. They are usually in large masses of one layer and in regular rows, and covered with gray hairs from the abdomen of the moth. There may be from 100 to 300 in one cluster. One moth may lay several hundred eggs; one specimen which I had in a breeding cage laid 700. The egg masses are not placed necessarily on the food plant; but usually high up, often on the leaves of banana and small palms, or other small trees or shrubs at three to five feet elevation. It is also common to find them on the sides of buildings and other structures. In one instance I found a batch of eggs ten feet up on the side of a building. The eggs hatch in three to four days from the time they are laid, and the tiny larvae drop to the ground by means of a silken thread, where they will find grass or other suitable food plant. They feed at first at the tips of leaves, eating the green substance of the leaf and leaving the epidermis, which dries up, giving a dead appearance. When a few days old, they eat the entire substance of the leaf from its margins, producing notches and a very ragged appearance.

After molting five times at intervals of two to six days, the caterpillars become full-grown in two to three weeks (Plate II, figs. 8, 9). They are then about 1.3 inch long (35 mm.). They vary a great deal in coloration. Some are nearly uniform grass green with median dorsal and sub-dorsal white lines; others are nearly black, with a sub-dorsal stripe and a stripe on line with spiracles darker than the rest, and a yellowish (sometimes pinkish) stripe below spiracles, underside pale. There are all gradations between these two. A common form is green with the sub-dorsal and spiracular stripes black; another form has the stripes broken up into a series of black spots, one spot to each segment. The spiracles are always black, and in the black form there is a white dot a little above and behind the spiracle

on segments 5 to 12. Hairs minute. Tubercles inconspicuous.

The pupa is formed in an earthen cell a little below the surface of the soil. It is medium dark brown, a little more than half an inch in length (12 to 15 mm.). At its apex are two straight slender-pointed spines set rather wide apart and nearly parallel.

The moth emerges from the pupa in eight to fourteen days, and is ready for egg-laying in two to four days. Thus the whole life cycle occupies only five to six weeks. With wings spread, the moth is 1.25 to 1.50 inches (30 to 35 mm.). The fore wings of the female are a dark gray with darker waved lines crossing at one-third and two-thirds from the base, a row of triangular black dots on terminal margin, and two or three marks a little before terminal margin. A little before middle of wing is an oval yellow spot. The hind wings are whitish with brown on margins and veins. The forewings of the male are much paler than those of the female and have varying shades of very pale brown; the lines and markings are more distinct.

THE LESSER NATIVE CUTWORM.

Agrotis dislocata (Walker).

Plate II, figs. 3-6.

This is a native cutworm and often becomes a bad pest in sugar cane, as well as in gardens and also on other crops. From my observations, it is more injurious to garden crops than to cane; but they are often reported numerous locally in cane fields. I have often taken them in cane fields in company with the army worm (*Leucania unipuncta*). They are slightly larger than the latter, and have more strictly the cutworm habit of feeding; that is, of hiding during the day in the soil or under trash and rubbish on the surface of the soil, and feeding at night on the lower leaves of the plant.

LIFE HISTORY.

The eggs (Plate II, figs. 5, 6) are laid at the base of plants, or even scattered on the soil, sometimes singly, sometimes two or three adhering together, and sometimes as many as a dozen in a bunch together or even a hundred or more in an irregular one-layered mass. They are of a yellowish white color, nearly

spherical, 0.8 mm. in diameter, minutely reticulated at upper pole and radiately ridged from it down the sides.

They hatch in a week or ten days. The caterpillars molt five times at intervals of four to six days, attaining their full-growth (36-40 mm.) in three to five weeks (sometimes much longer than this in hot, dry seasons).

The full-grown caterpillar (Pl. II, fig. 4) is of a dirty brownish color, with a broad lighter brown stripe on the back; under side dirty whitish. Tubercles black, a row of them on each side of the dorsal lighter stripe, are larger and more conspicuous than the rest. Hairs short, black. Spiracles oval, black. Head rather small proportionately, brown with blackish spot above each eye cluster, and two black bars in front converging above. The dorsal part of first segment behind head very dark brown. The full-grown caterpillar forms an earthen cell in the ground a few inches below the surface. After four to six days it transforms to the pupa which is similar in form to the pupa of *Leucania unipuncta,* about 17 mm. long, and of a pale yellowish brown color. The moth appears in 15 to 20 days, which makes a period of about two months from the time eggs were laid.

The moth (Pl. II, fig. 3) with wings expanded is about 1½ inches, or 40 mm. It is of a whitish grey color. The fore wings have a longitudinal white streak for more than half their length, behind which is a shorter blackish streak, which in turn has a yellowish streak behind it. The veins are marked with dark lines, and there is a row of dark dots on termen. Hind wings a little darker, with pale fringe. The wings when at rest are held straight backward over the back, often tipped so as to lie close along the sides of abdomen.

THE LARGER NATIVE CUTWORM.

Agrotis crinigera (Butler).
Plate II, figs. 12, 13.

This is another native cutworm, and is often a bad pest. It sometimes occurs in sugar cane; but more often attacks other vegetation rather than grasses and cane. It is fond of garden peas and beans and other garden plants, and I have found them abundant in fields of cow peas. I have also found them feeding abundantly on a native shrub (*Sida*), also on several kinds

of weeds as *Portulaca* and *Datura* ("Kikania"). The caterpillars usually hide in the soil or below debris in the daytime; but I have frequently observed them feeding on the plants in the daytime, and have also found them hiding among the leaves.

LIFE HISTORY.

The egg-laying habits are unknown. From very small caterpillars which I have found and reared, I estimate that it takes the caterpillars about one month to six weeks from hatching till they are full-grown. They are then 45 to 50 mm. in length and are more plump than other cutworms; in fact, this is the largest of our common cutworms.

The full-grown caterpillar (Plate II, fig. 13) is quite similar to that of *Agrotis dislocata,* but quite a bit larger; more blackish above, and paler below; the tubercles are not so conspicuous, the row below spiracles pale instead of black. The head lacks the black spot above eye cluster.

The pupa is formed in an earthen cocoon 30 mm. by 15 mm. It is 21 to 25 mm. long; light brown in color, darker on the back. The pupal period is 21 to 25 days, thus the life-cycle from egg to adult moth is probably a little more than two months, occupying a little longer period than the other common species on account of its larger size.

The moth (Plate II, fig. 12) measures two inches with its wings spread. It is of a brownish grey color, the male paler than the female. The male also has large tufts of yellowish hairs at the apex of the abdomen. The fore wings have some darker markings, viz., a roundish area a little anterior of the middle of the wing, an oval ring a little nearer to the base, a zigzag line across the wing about one-third the distance from the base, another zigzag line about three-fourths from the base, a row of triangular dots at termen. Hind wings nearly uniform very pale brown, a little darker on the veins.

THE GREASY CUTWORM.

Agrotis ypsilon Rottenburg.
Plate II, figs. 1, 2.

This is a well-known garden cutworm throughout the United States. It ranges in America from Hudson Bay south to Uruguay; is common in Europe; also occurs in northern and

southern Africa, India, China, Japan, Java, Australia and New Zealand. It is a typical cutworm in its feeding habits, i. e., feeding on plants at night-time, often cutting off small plants at or below the surface of the soil, and hiding under leaves, trash, or burrowing in the soil during the daytime. It is a very general feeder, attacking nearly all kinds of garden and field crops, and even weeds. I have never found it very abundant in cane fields, nor have I known of it being reported so, though it does frequently occur along with the other species and is partially responsible for the damage done. I have found them in fields of young cane, when no evidence could be found of their having eaten the cane. They were beneath plants of pigweed (*Purslane*) upon which they must have fed. In the United States they are particularly troublesome to corn, cotton, cabbage, tomato, and tobacco, attacking the young plants, one cutworm often destroying several plants in one night. In India they are destructive to young tea and coffee plants and opium.

LIFE HISTORY.

The eggs are domeshaped, about 0.5 mm. in diameter, and creamy white in color. There is a small circular depression at the upper pole from which radiate numerous ridges running down the sides to the base or surface in contact with a leaf The eggs are laid on the surface of leaves or stems of plants near to the ground. From one to many eggs may be placed close together in one batch, and one moth may produce several batches amounting to two or four hundred eggs.

The larvae hatch from the eggs in a few days (usually two to four). They molt five times at intervals of two to six days and become full-grown in about one month. The full-grown caterpillar (Plate II, fig. 2) is about 1.75 inches long (45 mm.). It is of a nearly uniform dark greasy gray color, paler below. The spiracles are black. The tubercles are conspicuous, showing as regular rows of brownish dots. Head and dorsal part of segment behind head dark brown.

The pupa is formed in an earthen cell a little below the surface of the soil. It is about .75 inch long (20 to 23 mm.), uniform medium brown in color, with a dark dorsal band at apex of abdominal segments 4, 5, 6 and 7, containing irregularly arranged small pits. At the tip of abdomen are two large tapering spines, black at base and pale at tip, a little distance

apart at base, slightly diverging but curved together at their tips.

The moth (Plate II, fig. 1) emerges from the pupa in ten days to three weeks. It is about two inches in expanse of wing. It is of a dark gray color with black eyes and collar. The fore wings are velvety blackish brown except the outer one-third, which is paler brown. There is a distinct U-shaped black mark a little beyond middle of wing, a black dash extending from its outer side, and two black dashes farther toward the end of the wing. Hind wings light gray, brown on outer margin and on veins.

THE VARIEGATED CUTWORM.

Agrotis saucia (Huebner).

Plate III, figs. 1, 2.

This is another cosmopolitan cutworm, being widely distributed over Europe, Asia, North Africa, North and South America, from Canada to Argentina.

It is a general feeder, eating the usual garden and field crops and not particularly grasses. It is also a green-house pest in the States, feeding largely on violets and other ornamental plants. In the Hawaiian Islands, besides feeding on garden crops it also feeds upon sugar cane to some extent, being frequently found in cane fields along with the army worm. Brother Matthias Newell of Hilo has reared them on orange leaves, from an egg mass found on an orange leaf. They also feed upon some common weeds. I have found them quite numerous on "pualele" (*Sonchus*), and occasionally on "kikania" (*Datura*), *Xanthium* and purslane. They often remain feeding on the plants in daytime.

LIFE HISTORY.

The eggs are deposited in regular masses, often in regular rows on the surface of leaves or twigs, usually a large number in a mass, often several hundred. The egg is about .6 mm., hemispherical, flattened on the surface in contact with the leaf or twig. It is radiately ribbed from the upper pole, and has minute cross ribs between these. The young larvae are green with black heads. They molt five times before attaining their full growth, which takes about a month, or a little more.

The full-grown caterpillar (Plate III, fig. 2) is about 1.75 inches (40-45 mm.). It varies much in color. Head pale brown, reticulate with dark brown, a slight line upward from eyes, two curved vertical broad dark bands in front. Body brown, more or less generally mottled with darker and lighter brown and some yellowish; dorsal line pale yellowish often broken into a series of yellowish patches on segments 4-7, (sometimes on segments 3-9); segment 12 mostly yellow dorsally on posterior part; a yellowish line below the spiracles, which are black. Tubercles and hairs very minute. In darker forms the browns are nearly black. There is a more or less irregularly interrupted blackish streak just above the line of spiracles. A sub-dorsal line consisting of blackish spots on each segment. On several of the segments there is a dorsal lozenge-shaped spot slightly darker than the general color, but not so dark as the blackish stripes. A blackish spot on outer side of each proleg.

The pupa is formed in the ground a few inches below the surface, or beneath trash. It is 19 mm. in length, and of a uniform medium brown color, its apex armed with two spines very close together, the basal half of each spine black, the tips white. The moth appears in two or three weeks.

This moth (Pl. III, fig. 1) measures 1.75 to 2 inches (45-50 mm.), with wings spread. It is of a pale grayish-brown, tinged faintly with reddish. The fore wings are shaded about the middle and toward the outer margin with darker brown, and a row of dark triangular dots on the outer margin. There are two roundish-oval lighter spots a little forward of the middle of the wing. The hind wings are paler at base, and darker about the margins and on the veins.

REMEDIES.

The ravages of army worms and cutworms may be checked by poisoning them. One method is to spray the poison onto the plants in liquid form. For this, Paris green may be used, or Disparene; the former at the rate of one-half pound per 50 gallons of water; the latter at the rate of two pounds per 50 gallons of water. The most general practice in these Islands is using poisoned bait. For this, Paris green is mixed with bran or middlings. To make this, add two or three ounces of sugar or molasses per gallon of water, then stir in bran at the

rate of about one pound per gallon of water. Thoroughly mix poison with this at the rate of one pound per 50 pounds of the moistened bran. This mixture is to be scattered throughout the infested regions. The mixture may be made dry, using one pound of Paris green to 20 pounds of bran and middlings mixed in equal parts. Another method of applying poisoned bait is to spray with poison some green crop as grass, clover, or alfalfa; then cut this and scatter in the infested regions, preferably late in the afternoon, so that it will not become too much wilted before the cutworms feed upon it in the evening. The advantage of using poisoned bait in a cane field is that the cutworms hiding in the ground during the day are most likely to eat the poisoned bait when coming forth at night to feed, rather than climbing the young cane shoots to feed on their leaves.

NATURAL ENEMIES.

BIRDS.

One of the best checks to the increase and ravages of the army worms is the mynah bird. This bird was introduced from India about twenty or more years ago, for the very purpose of feeding upon army worms and cutworms. Although it has some other undesirable habits, yet it is very valuable for this purpose. It has increased probably to its maximum limit, and is perhaps at present somewhat reduced in numbers on account of the lack of Lantana berries which at one time formed a large part of its diet.

It is to be found practically everywhere throughout the Islands, at least the habitable and cultivable portions. With its increase has come the decrease in devastation by army worms and cutworms; whereas previously it is reported that whole fields of young cane were stripped off by the great numbers of caterpillars, and that grass lands of great areas were likewise totally eaten off, particularly by the grass army worm (*Spodoptera mauritia*), in recent years the damage has been slight compared with formerly.

The golden plover (*Charadrius fulvus*) also lives largely on these caterpillars. They come from Alaska to these Islands for the winter season, coming in August and remaining till the following April. Before leaving they become very fat from

their cutworm diet. In regard to their habits, I quote from Dr. Perkins in Fauna Hawaiiensis:

"In many parts of the Islands large numbers of plover habitually resort to the margin of the sea and the extensive mud-flats for feeding purposes, but the greater part scatter over the lower-lying grass lands and the open mountain country, where they may be found even as high as five or six thousand feet above the sea. In such localities they find abundant food in the caterpillars of various Noctuid moths, and indeed in the moths themselves. Of all the Island birds the plover is beyond question the most valuable to the grazier and the agriculturist, and it is singularly unfortunate that it is a most excellent bird for the table, and at the same time the one most generally sought after by sportsmen.

"I have been at some pains to learn exactly the species of Noctuidae which form the favorite food for the plover, whether as moth or caterpillars, and I have several times shot the bird at the instant that it has seized a moth in its hiding-place at the roots of grass. I am therefore able to state positively that it catches the moth both of *Agrotis crinigera* and *dislocata*, the caterpillars of which are the two most extremely injurious and wide-spread of all the Island 'cutworms.' It also obtains the caterpillars of both these and other species and feeds, as is well known, to an enormous extent on the grass army-worm (*Spodoptera mauritia*), a caterpillar which not only locally entirely clears off the freshly grown grass, but also does some damage to the young leaves of sugar cane.

"For these reasons the plover is worthy of all encouragement by the agriculturist and should never be shot on or around his land, or, if this is done, he should not complain when his crops are ravaged by cut-worms, as is often the case."

The English sparrow is abundant on Oahu, though not on all the other Islands, and has been observed to prey upon army worms to some extent.

TACHINA FLIES.

These parasites are very valuable in helping keep cutworms and army worms in check. They prey upon numerous other kinds of caterpillars also; I have reared one species from fourteen species of caterpillars, and another from eleven species.

There are eight native species of cutworms of the genus *Leucania*, and 24 species of the genus *Agrotis*. The most of these are rare, and are probably kept so by these parasites. They are found common on all of the Islands, and where cutworms or army worms are numerous they will be found numerous also. I have collected caterpillars in quantity in cane fields in different parts of the Islands and examined for maggots of these parasites, and often found as many as 25% to 35% of them parasitized. In one lot sent to the Experiment Station from Hamakuapoko, Maui, 70% were parasitized.

Frontina archippivora (Williston).

The habits of this species are given on pages 47 to 49 of Bulletin V, Experiment Station, H. S. P. A., Division of Entomology. It is figured on Plate VI, fig. 4.

Chaetogaedia monticola (Bigot).
Plate III, figs. 8-13.

This large Tachina fly was described from the Rocky Mountains; has also been reported from California. It occurs throughout the Hawaiian Islands, on the lowlands and well up into the mountains. They are found common wherever army worms or cutworms are numerous. In examination of numerous army worms collected at different times from several different districts, not so many were parasitized by this Tachina as by *Frontina archippivora,* yet a good many were; and of the rarer native cutworms which I have obtained specimens of from time to time, more were parasitized by *Chaetogaedia* than by *Frontina;* in fact, it is difficult to get specimens of some of the native cutworms which are not parasitized. Other species of caterpillars are also parasitized by this Tachinid. I have reared it from 11 different species of caterpillars.

This fly is much larger than a house fly, and of much the appearance of the large grey flesh fly, from which, however, it may be readily distinguished by its habits and flight. It is more solitary, and does not frequent decomposing substances.

LIFE HISTORY.

It is but recently that I discovered the method of egg-laying of this fly. It is usually stated in entomological literature that Tachina flies lay their eggs on the bodies of their hosts; in fact with certain species the act has been observed, but for far the greater number of them the act of egg-laying has not been observed or at any rate not recorded. That *Chaetogaedia* had a different method of laying eggs, was surmised, when in June, 1907, this parasite was reared from more than half of a lot of pupae of *Agrotis cinctipennis,* one of the less common native cutworms. The eggs of this lot of cutworms were hatched in breeding cage and grew to maturity without the possibility of access of a Tachina fly; hence, considerable of a mystery arose when more Tachinids than moths bred out from the lot.

This mystery was not cleared up till in February, 1908, when in watching a female *Chaetogaedia,* as I supposed, hunting for caterpillars amongst grass and weeds, I observed that she was laying eggs on the grass leaves. She would quickly crawl around among the leaves, only stopping momentarily to place an egg here and there on the surface of a leaf, never more than one per leaf. They were placed on the leaves of weeds as well as on the grass. After making this observation, it was easy to explain how the caterpillars previously alluded to, became parasitized; for they were daily supplied with food (mostly *Sonchus*) gathered from outside where Tachinas were common, and had undoubtedly deposited many eggs on the leaves. The caterpillars ate the leaves with the eggs thereon, which hatched inside and grew to maturity, not, however, killing the caterpillars till after the latter had transformed to pupae.

I have since learned that another Tachina fly has similar habits of laying its eggs, the "Uji," which is very destructive to silk worm caterpillars in Japan. This is the only instance I have found in entomological literature of a Tachinid laying its eggs otherwise than directly on the host (caterpillar, grass hopper, or whatever it is).

The egg of *Chaetogaedia* appears as a tiny black dot on a grass leaf (Plate III, figs. 12, 13). It is .4 mm. long by .25 mm. broad, quite regularly ovate, shaped like a hen's egg only somewhat flattened where in contact with the leaf; smooth and shining black. A female dissected was found to have several hundred of them in the ovarian tubes. Probably many that are laid are not eaten by caterpillars; hence the provision of such a large number to insure some of them being eaten. They are so small as to escape being injured by the jaws of the caterpillars in biting off bits of leaf, though probably some are destroyed. They soon hatch in the alimentary canal of the caterpillar and bore through its walls to the surrounding body cavity. If they did not hatch the same day they would probably pass out with the excrement.

A caterpillar which had been fed with leaves on which quite a number of *Chaetogaedia* eggs had been smeared, died after five days. It was dissected and twenty-four maggots of the parasite were found inside. They were about 2mm. long. Other caterpillars which had been similarly treated and died, were dissected, and smaller numbers of maggots found. The

maggots grow on the juices and fat of the caterpillar; they eventually all die but one, however. It does not become full-grown until after the caterpillar has pupated; then it soon finishes eating the fatty substance and forms a large cylindrical puparium (Plate III, fig. 10), rounded at the anterior end, and rather blunt at the posterior end, where it is often somewhat widened. The puparium is very dark reddish in color, and each of the two spiracular orifices at the posterior end has three black rounded protuberances around it. The puparium is always formed within the pupa of the host, and never more than one. The adult fly emerges in 11-14 days from the time the puparium is formed.

KOEBELE'S ICHNEUMON.

Ichneumon koebelei Swezey.
Plate III, fig. 7.

This valuable parasite was introduced from America by Mr. Koebele several years ago. The date of introduction is not known; but after becoming established the first record of its appearance is a specimen taken by Dr. Perkins, in June, 1900. Since then it has become generally spread, and quite common locally, usually the most observed where there is an abundance of army worms and cutworms. During 1905-1907, I have seen them quite abundant at several places on Hawaii, Maui and Oahu; but so far I know of no records of its occurrence on Kauai or Molokai. It was especially introduced to prey upon army worms and cutworms, and I do not know of it attacking any other kind of caterpillar.

LIFE HISTORY.

Little is known of its life history, further than that the female parasite deposits her egg inside a living caterpillar; the larva there lives upon the fluids and fat, not causing the death of its host until after the latter has pupated; then the parasite completes its growth and becomes a pupa within the host pupa, and in due time the adult parasite emerges therefrom.

The insect has somewhat the appearance of a wasp, though more slender in build. The female is a little more than half an inch long, and the male a little less than three-fourths of an inch. The female is of yellowish red color, with black eyes,

apical half of antennae black, and two black dorsal bands on the abdomen. The male is less reddish and more yellowish, its antennae are all black except at base, and there are four dorsal black bands on the abdomen. The wings of both sexes are slightly smoky.

Specimens were submitted to Dr. Howard of the Bureau of Entomology, Washington, for identification. He has kindly compared them with specimens in the U. S. National Museum, and found that it is not contained there. He writes further regarding it: "I then sent it to Mr. Viereck, who compared it with the Philadelphia collection, and while, he says, it comes near to *Ichneumon brevipennis,* it is evidently distinct from that species." Hence, it is apparently an undescribed species, and I propose for it the name *koebelei.* The technical description will be given in a forthcoming bulletin.

EXPLANATION OF PLATES.

PLATE I.

Cane shoot badly eaten by army worms.

PLATE II.

1 *Agrotis ypsilon*, male.
2 " " caterpillar; p. prolegs, s. spiracles, t. tubercles.
3 *Agrotis dislocata*, male.
4 " " caterpillar.
5 " " cluster of eggs.
6 " " egg highly enlarged.
7 *Spodoptera mauritia*, male.
8, 9 " " caterpillar. (two color varieties).
10 " " cluster of eggs.
11 " " egg highly enlarged.
12 *Agrotis crinigera*, male.
13 " " caterpillar.

PLATE III.

1 *Agrotis saucia*, male.
2 " " caterpillar.
3 *Leucania unipuncta*, male.
4 " " caterpillar.
5 " " pupa.
6 " " apex of pupa highly enlarged.
7 *Coelichneumon kocbelei*, female.
8 *Chaetogaedia monticola*.
9 " " larva.
10 " " puparium.
11 " " posterior segment of puparium highly enlarged.
12 " " egg on grass leaf, enlarged.
13 " " egg highly enlarged.

PLATE I.

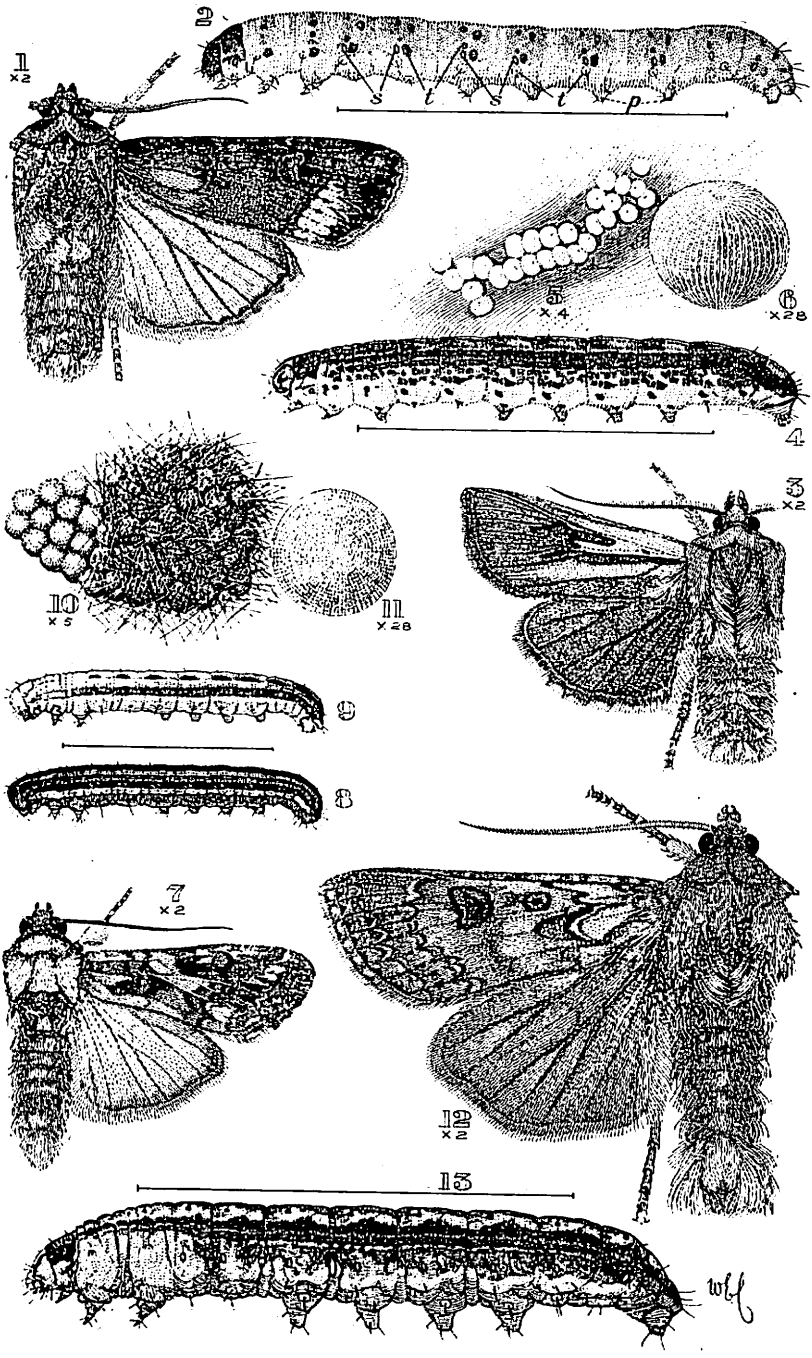

PLATE II.

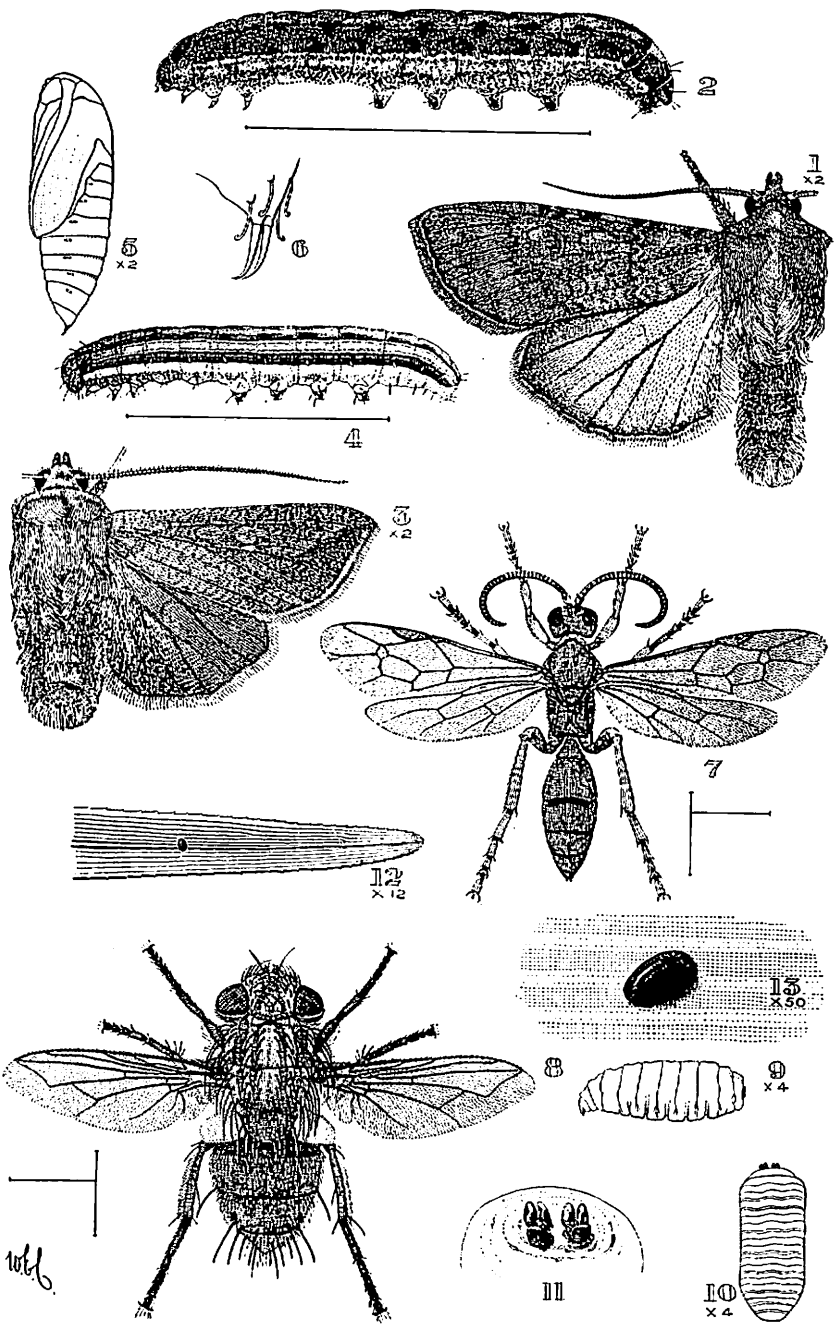

PLATE III.